integrity Research Journals

Journal of Animal Science and Veterinary Medicine
Volume 7(1), pages 28-33, February 2022
Article Number: 744E53BE4
ISSN: 2536-7099
https://doi.org/10.31248/JASVM2021.280
https://integrityresjournals.org/journal/JASVM

Full Length Research

Metabolized energy values of succulent leaf meal of *Vernoma amygdalina* mixed with *Musa sapientum* leaf meal on performance of growing pigs

R. P. Obongekpe

Department of Animal Science, University of Uyo, Uyo, Akwa Ibom State, Nigeria.

Email: obongekperichard2@gmail.com

Received 5th July, 2021; Accepted 12th August, 2021

ABSTRACT: This study investigated the metabolized energy values of succulent leaf of *Vernoma amygdalina* (Bitter leaf meal) mixed with *Musa sapientum* leaf (Banana leaf meal) (BBLM) on performance of growing pigs. The experiment was conducted at the Swine Unit of the Teaching and Research Farm, University of Uyo, Uyo, Akwa Ibom State, Nigeria. A total of 40 large white breeds of pigs (growers) were used for the study. The pigs were divided into 5 groups based on average initial weights (20 to 25 kg) and each group of grower pigs were respectively allotted to each of the five treatment diets using a completely randomized design (CRD). Each treatment group contained 2 replicates of 4 pigs (2 males and 2 females). These pigs were fed twice daily and water supplied was given *ad libitum*. The treatment diets consisted of BBLM at 0 (control), 20, 40, 60 and 80%. The 50:50 ratios of banana leaf and bitter leaf meal were derived by equal weighing (kg) of the two test ingredients percentage in the diet using a manual scale. All diets were formulated to be iso-nitrogenous and iso-caloric. During the feeding trial, daily feed consumption, metabolized energy values, weight changes, and nutrient digestibility were determined and recorded for all the levels, while weight gain, feed conversion ratio and protein efficiency ratio were estimated to assess performance of the weaner pigs. The results revealed that metabolized energy values of BBLM as shown in T_1, T_2, T_3, T_4 and T_5 obtained in this study were significantly ($p<0.05$) increased in each of the diets. The reason for the significant increase was as a result of the presence of banana leaf meal in the feed formulation due to its high fibre content. The results from the study also showed significant ($p<0.05$) differences on the performance characteristics of grower pigs. It was found that animals on 80% diet gave the best performance compared to other diets in final weight gain, feed conversion ratio and protein efficiency ratio (25.67 kg, 2.06 and 2.52) respectively. There were significant differences ($p<0.05$) on the nutrient digestibility of the pigs. It was concluded that the metabolized energy values of BBLM increases as the level of inclusion were higher and as such can completely replace maize as a source of energy without adversely affecting the overall growth performance of the pigs.

Keywords: Metabolized energy, *Musa sapientum*, pigs, *Veronoma amygdalina*.

INTRODUCTION

Rearing and production of pigs is becoming very expensive due to high cost of energy feeds. According to Ademosun (2016), feed cost account for 60 to 80% of livestock production costs and the energy component of feed accounts for 40 to 60%. Within tropical environments, there are many feedstuffs that could contribute greatly to increased energy production if properly utilized in animal production to reduce the amount of imported raw material for livestock and competition that exist between humans and animals in energy crop consumption. Banana is an important agricultural export commodity for many tropical and subtropical countries. In practice, bananas are harvested green, and the fruits whose quality does not meet the expected standards are rejected for export and it has been reported as an alternative feedstuff, which can be used as energy source for animal feed because they

are rich source of carbohydrate and high contents of sugars (riped banana), while the unripe banana are mainly good source of vitamins mineral premix and iron (Imam and Akter, 2011; Tsen *et a.l*, 2004). Moreover, Renaudeau *et al*. (2014) reported that grower pigs that were fed up to 60% banana in place of corn had no effect on final body weight, average daily gain and feed conversion ratio.

Despite the fact that banana production is a fruit crop, it generates large amounts of forage material that can be used to feed livestock. Banana leaves, which grow continuously from the center of the stem, are broad blades, 1 to 4 m long x 0.7 to 1 m wide, with a pronounced supporting midrib. Banana leaves and petioles are sometimes called banana tops. Also, banana pseudo stems, usually called banana stems, banana stalks or banana trunks, are cylindrical, made of overlapping leaf-sheaths, and 20 to 50 cm in diameter. According to Ecocrop (2010), the banana leaves and pseudostems can be fed to animals in fresh, ensiled or dried form. Banana leaves contain about 85% water and 10 to 17% protein (DM basis). Pseudostems contain mostly water (92 to 95%) and very little protein (3 to 4.5% DM) (Ffoulkes *et al*., 1977). Fibre content is high, in the 50 to 70% DM range for NDF and about 30 to 40% DM for ADF (Heuzé *et al*., 2011). The banana foliage contains large amounts of total polyphenols (up to 8% DM), mostly in the leaves, but very few condensed tannins (Marie-Magdeleine *et al*., 2010).

Furthermore, Kimambo *et al*. (1991) reported that there are significant differences in degradability and digestibility of banana leaves and pseudo stems. Unlike other plants, the digestibility of stems is higher (75%) than that of leaves (65%) (Ffoulkes *et al*., 1978) and OM and DM disappearance follow the same pattern. The probable explanation is that the erectness of pseudo stems is achieved by the way in which water is held in the cells, and not by the presence of high levels of lignin in the cell wall (Ffoulkes *et al*., 1978). The high tannin content of leaves may also explain their lower digestibility (Marie-Magdeleine *et al*., 2010; Kimambo *et al*., 1991).

Inclusion of banana leaf meal up to 40% in the forage ration increased weight gain and feed efficiency of Zebu cattle and sheep (Garcia *et al*., 1973). In growing calves, a 40:60 mixture of pseudo stems and corn silage reduced feed costs and increased digestibility, but DM intake and body weight decreased (Dormond *et al*., 2001). In the Seychelles, young crossbred Jersey steers fed chopped banana leaf and pseudo stem residues supplemented with urea/molasses and leucaena foliage experienced growth rates of 0.4 kg/day (Preston *et al*., 1987). Weight gains between 0.5 and 0.7 kg/day were obtained on steers fed banana tops supplemented with molasses and urea (Rowe *et al*., 1978). In Zanzibar, banana forage could provide maintenance rations in the dry season and reasonable growth in penned animals when combined with other feeds (Reynolds, 1995). According to Buragohain *et al*., (2010), like other banana products, banana foliage and crop residues can be an important staple food for pigs for smallholders in banana-producing areas. Banana leaf meal could replace up to 15% of diet DM in growing pigs, resulting in satisfactory average daily gain and feed conversion (García *et al*., 1991). However, banana leaf meal had a detrimental effect on ileal and faecal digestibility of most nutriments, including protein, which suggest that it should be used at low inclusion rates in pig diets (Ly *et al*., 1997). Anthelmintic properties have been demonstrated in the 1950s but need to be confirmed by more recent research (Olivo *et al*., 2007).

Furthermore, research has also shown that *V. amygdalina* have some beneficial effects in disease management of pigs (Ekeocha, 2011), such as anti-coccidiosis, antibacterial and anti-parasitic (Gbolade, 2009); as an antioxidant (Erasto *et al*., 2006) and as a growth promoter enhancing the gastro intestinal enzymes thus increasing feed conversion efficiency (Opata and Izevbigie, 2006). *Vernonia amygdalina* (VA) is a shrub or small tree that grows throughout tropical Africa. It is popularly called bitter leaf because of its abundant bitter principles (Ekpo *et al*., 2007). The leaves contain a considerable amount of antinutritional factors like high level of tannic acid and saponin (Erasto *et al*, 2006), high cyanide (60.1 mg 100^{-1} g Dry matter, DM) and tannin content (40.6 mg 100^{-1} g DM) in young leaves than older ones (Tadesse *et al*., 1993). Proximate composition of *Vernonia amygdalina* leaf meal (VALM) shows a chemical composition of 527.83 ME kcal/ kg, 86.40% DM, 21.50% CP, 13.10% CF, 6.80% EE, 11.05% Ash, and the result on mineral composition indicate that *V. amygdalina* has 3.85% Calcium, 0.40% Magnesium, 0.03% Phosphorus, 0.006% Iron, 0.33% Potassium and 0.05% Sodium (Owen and Amakiri, 2011). It has also been reported to contain alkaloid, carbohydrate, tannin, saponin, flavanoids and non-cyanogenic glycosides (Olobatoke and Oloniruha, 2009) and has active antimicrobial activity (Koshimizu *et al*., 1993). *V. amygdalina* and *Musa sapientum* are cheap and readily available in many household gardens in Nigeria. Hence, the objective of the study was to determine the metabolized energy values of succulent leaf of *Vernoma amygdalina* mixed with *Musa sapientum* leaf meal on performance of growing pigs.

MATERIALS AND METHODS

Location of study

The experiment was conducted at the Swine Unit of the Teaching and Research Farm, University of Uyo, Uyo, Akwa Ibom State. Akwa Ibom State is in Nigeria. It is located in the coastal southern part of the country, lying between latitudes 4°32'N and 5°33'N, and longitudes 7°25[1]E and 8°25'E. The state is located in the south-south geographical zone, and is bordered on the east by Cross River State, on the west by Abia State, and on the south by Atlantic Ocean.

Table 1. Composition of experimental diet for growers pig.

Ingredients	T_1 (0%)	T_2 (20%)	T_3 (40%)	T_4 (60%)	T_5 (80%)
Maize	60.00	40.00	20.00	8.00	0.00
BBLM	0.00	20.00	40.00	60.00	80.00
Ground Nut Cake	25.15	26.78	27.92	23.05	12.08
Wheat Offal	9.55	6.92	5.58	2.20	1.02
Bone Meal	1.50	1.50	1.50	1.50	1.50
Limestone	2.00	2.00	2.00	2.00	2.00
Palm Oil	1.00	2.00	2.20	2.00	2.60
Weaner Premix*	0.25	0.25	0.25	0.25	0.25
Salt	0.35	0.35	0.35	0.35	0.35
Ronozyme**	0.20	0.20	0.20	0.20	0.20
Total	100.00	100.00	100.00	100.00	100.00
Calculated analysis:					
Crude Protein (%)	25.00	25.00	25.00	25.00	25.00
ME(Kcal/Kg)	2878	2847	2815	2810	2781
Fibre (%)	5.35	6.99	8.63	10.26	11.90
Ash (%)	5.94	9.11	12.34	15.57	18.80
Calcium (%)	0.80	0.80	0.80	0.80	0.80
Starch (%)	39.20	36.14	32.99	29.85	26.70
Fat (%)	6.48	7.74	8.99	10.25	11.50

*BBLM – Banana and Bitter leaf meal, ME = Metabolizable energy.

Processing of banana meal and bitter leaf meal (BBLM)

Fresh leaves of banana and *Vernonia amygdalina* were obtained from the university garden, washed, air-dried for four days and ground into powder using a grinder. The ingredients were then mixed based on their chemical composition and levels of inclusion to prepare the compound experimental rations to form banana and bitter leaf meal (BBLM). The five treatment rations used in this study were formulated on an isocaloric and isonitrogenous basis in such a way to consist 2800 to 2900 kcal ME per kg DM and 16 to 17% CP for pigs (NRC, 1994).

Experimental design and treatments

The design of the experiment was a complete randomized design (CRD) with 5 dietary treatments. A total of 40 grower pigs of large white were used for the study. The pigs were divided into 5 groups based on average initial weights (20 to 25kg) and each group of grower pigs were respectively allocated to each of the five treatment diets. Each treatment group contained 2 replicates of 4 pigs (2 male and 2 female). These pigs were fed twice daily and water supplied *ad libitum*. There were five diet groups comprising:

T1 = 0% of Banana and Bitter leaf meals (BBLM) (control)
T2 = 20% of BBLM
T3 = 40% of BBLM
T4 = 60% of BBLM
T5 = 80% of BBLM

Data collection

The pigs were weighed at the beginning of the experiment to obtain their initial live weight and subsequently weighed on weekly basis. The pigs were fed twice daily, in the morning by 8.00 am and in the evening by 5.00 pm. Feed intake was obtained as the difference between quantity offered and quantity left over. During the feeding trial, daily feed consumption, metabolized energy values, weight changes, and nutrient digestibility were determined and recorded for all the levels. Also, weight gain, feed conversion ratio and protein efficiency ratio were estimated to assess performance of the weaner pigs.

Statistical analysis

Data were subjected to analysis of variance using the procedure outlined by SAS (2002) and significantly different means were separated using the multiple range test by Duncan (1955).

RESULTS AND DISCUSSION

Table 2 shows the results of the proximate and energy composition of the processed forms of BBLM. The nutrient composition of T_1 BBLM was significantly lower than that of other processed forms. The crude protein of BBLM was

Table 2. Proximate and energy composition of banana and bitter leaf meals (BBLM).

Ingredients	T1 (0%)	T_2 (20%)	T_3 (40%)	T4 (60%)	T_5 (80%)	SEM
Dry matter (%)	79.49[b]	86.90b	87.39[c]	88.10[a]	89.53	0.03
Crude protein (%)	8.39[d]	9.87c	10.18[a]	12.85[b]	14.18[a]	0.01
Crude fibre (%)	9.98[c]	12.59a	7.94d	10.52[b]	7.94[d]	0.21
Ether Extract (%)	4.72[a]	5.12c	5.33[b]	5.71[a]	5.33[b]	0.02
Ash (%)	5.78[d]	14.80b	12.78[c]	17.53[a]	12.78[c]	0.06
NFE (%)	44.55[d]	43.86b	52.27[a]	50.94[b]	52.27[a]	1.17
Metabolized energy Kcal/kg	2617.00	2790.00	2832.00	2917.25	2918.00	0.023

[a,b,c,d] Means on the same row with different superscripts are significantly different ($p<0.05$).

Table 3. Growth performance characteristics of grower pigs fed experimental diet.

Parameters	Levels of inclusion (%)					SEM (±)
	T_1 (0%)	T_2 (20%)	T_3 (40%)	T_4 (60%)	T_5 (80%)	
Ave. initial weight(kg)	10.05	10.08	10.00	10.01	10.00	-
Ave. final weight(kg)	28.84[b]	30.67[a]	35.00[c]	38.50[d]	40.84[d]	0.03
Ave. total weight gain(kg)	12.52[b]	23.79[a]	26.00[d]	30.50[cd]	35.84[d]	0.44
Ave. weekly weight gain(kg)	2.07[b]	2.40[a]	1.86[c]	1.78[cd]	1.89[d]	0.64
Feed intake(kg)	35.00	35.00	35.00	35.00	35.00	0.01
Feed conversion ratio	2.41[c]	2.06[d]	2.69[b]	2.80[b]	2.96[a]	0.68
Protein efficiency ratio	2.18[b]	2.52[a]	1.95[c]	1.88[cd]	1.98[d]	0.08
Mortality (%)	-	-	-	-	-	-

[a,b,c,d,e] means along the same row with different superscripts are significantly ($p<0.05$) different from each at her, Ave: Average, SEM: Standard error of mean.

significantly ($p < 0.05$) higher than control. The metabolized energy values of BBLM premix increases as the level of inclusion is higher (that is T_1 = 2617.00 Kcal/kg, T_2 = 2790.00 Kcal/kg, T_3 = 2832.00 Kcal/kg, T_4 = 2917.25 Kcal/kg and T_5 = 2918.00 Kcal/kg) respectively. This implies that the metabolized energy values of BBLM as shown in T_1, T_2, T_3, T_4 and T_5 obtained in this study significantly ($p < 0.05$) increases in each of the inclusion. The reason for the significant increase is as a result of the presence of banana leaf meal in the feed due to its high fibre contents. The same result was reported by Kimambo *et al*. (1991) and Uwalaka *et al*. (2013) for banana leaf meal respectively. However, the values of crude protein were comparable with the value 9.86% recorded for 20% of ripe plantain peels reported by Akinmutimi *et al*. (2006). However, the values of crude fibre, ether extract, nitrogen free extracts (NFE) and metabolizable energy did not agree with the reports of Uwalaka *et al*. (2013) and Ighodaro (2012). As reported by Ling *et al*. (1982), the gelatinization temperature of banana starch is higher than that of cereals (corn, wheat). These differences observed could be due to the variety of plantain, soil and other climatic factors that influence the availability of nutrients in plants.

Initial live weight of grower pigs ranged from 10.00 to 10.08 kg, average final weight gain of the grower pigs obtained as shown in Table 3 revealed that, experimental pigs were significantly ($p < 0.05$) affected by the experimental diets. Increasing levels of BBLM resulted in steady increase in body weight of 30.67, 35.00, 38.50 and 40.84 g for pigs on diets 2, 3, 4 and 5 respectively. Weight gains of pigs fed concentrate feed deprived of forage (Diet 1) dropped significantly ($p < 0.05$) to 28.84 g. Therefore, 80% BBLM supported the highest daily live weight gain in the pigs respectively. Feed intake values were not significantly affected at grower phase; results were the same across the groups.

Feed conversion ratio differed significantly ($p < 0.05$) in the experimental animals, while pigs on 20% (2.06) diet gave the best compared to other diets with corresponding values of 0 (2.41), 40 (2.69), 60 (2.80) and 80% (2.96) respectively. Protein efficiency ratio of weaner pigs was significantly ($p < 0.05$) influenced by the experimental diets, highest value was recorded in 20% (2.52) diet, followed by 0 (2.18), 40 (1.95), 60 (1.88) and 80% (1.78) in that order. There was no mortality throughout the 4 phase feeding trials. The result implies that increase of BBM has significant effect on the growth performance of grower pigs such as average final weight, average total weight gain, average weekly weight gain, feed conversion ratio and protein efficiency but continued increase in the feeds can lead to reduction on the growth performance of

Table 4. Nutrient digestibility of pigs fed BBM based-diets.

Ingredients	T_1 (0%)	T_2 (20%)	T_3 (40%)	T_4 (60%)	T_5 (80%)	SEM
Dry matter (%)	96.49[b]	97.90[b]	97.39[c]	98.10[a]	99.53	0.03
Crude protein (%)	72.39[d]	67.87[c]	67.18[a]	98.85[b]	63.18[a]	0.01
Crude fibre (%)	80.98[c]	71.59[a]	75.94[d]	81.52[b]	69.94[d]	0.21
Ether Extract (%)	93.72[a]	86.12[c]	89.33[b]	90.71[a]	85.33[b]	0.02
Ash (%)	83.78[d]	76.80[b]	90.78[c]	77.53[a]	72.78[c]	0.06

[a,b,c,d] means on the same row with different superscripts are significantly different ($p<0.05$).

pigs as seen in treatment condition 5 (80%). The increase in the result as feed increases maybe due to the presence of banana leaf meal during the T_5 (80%) diet which improved its palatability. Solà-Oriol *et al*. (2009) suggested that feed characteristics such as texture, taste or odor may be responsible for the change in feed preference in pigs. However, the study is in agreement with the reports of Restrepo and Gonzalo (1973), Celleri *et al*. (1971), Ly *et al*. (2004) and Heuzé *et al*. (2011) who observed feeding BBLM aid in growth performance as the level of inclusion gets higher.

The results of nutrient digestibility of pigs fed BBLM based-diets is presented in Table 4. The digestible nutrients were properly digested by the pigs, due to the high values of nutrient digestibility recorded in this study. Significant ($p < 0.05$) differences were observed in all parameters across dietary treatments but it was found that as the feed increases, the pigs started having difficulty in digestion as seen in T_5 (80%). This result was in consonance with the finding of Restrepo and Gonzalo (1973) and Ajayi *et al*. (2007). The disparity in digestibility responses could be attributed to the different test ingredients used in the separate studies. The faster growth rate observed in pigs fed with BBLM diet could be due to increased digestibility of nutrients at the initial increment of the fed, which might have resulted in better utilization of nutrients for better growth performance recorded in this study but low digestibility can be attributed to a change in chemical composition (more starch and less dry fibre, DF). The nutrient digestibility of pigs fed with 0 and 20% diets were comparable, the consistent decrease in nutrient digestibility of pigs fed the urea-treated BBLM diet might be due to low feed intake of the diet as a result of the presence of urea.

Conclusion

The study revealed that BBLM was significant with the growth performance of pigs ($p < 0.05$) as the feed increases. Dietary treatment had effect on the feed conversion ratio and feed cost per unit weight gain. Pigs fed the control diet (0% BBLM) were lowest in dressing percentage whereas counterparts on 80% with BBLM where highest in abdominal fat compared to pigs on other dietary treatments and reduces again at 60% feed increment. Results also showed that there was a high digestibility when BBLM was replaced with maize meal as level of inclusion increases. The findings of this study therefore implies that bitter leaf and banana leaf meals (BBLM) can be a good meal for all monogastric animals as it positively improves their performance. Also, it will reduce the cost of production and increase the profit margin. It is therefore recommended that;

1. BBLM should be used in pigs' nutrition to reduce over dependence on conventional feedstuffs by farmers.
2. Public extension/advisory staff should be mobilized to convey these results to practicing farmers.
3. Further research should be conducted on different ways or methods of reducing anti-nutritional factors in leaf meals.

CONFLICT OF INTERESTS

Author declares not conflict of interest.

REFERENCES

Ademosun, A. A. (2016). Livestock production in Nigeria: Our commissions and omissions. Inaugural Lecture Series 17. February 29, 1976. University of Ife Press, Ife.

Ajayi, A., G. Kalio, L. Agwunobi, S., & Okon, B., (2007). Agro by-product feedstuffs and livestock management systems for rural livelihoods in cross river state. *Journal of Agricultural Science, 3*, 191-197.

Buragohain, R., Kalita, G., & Sarma, K. (2010). Nutritional significance of banana as swine feed. *Indian Vetenary Journal, 87*(3), 301-302.

Celleri, H., Oliva, F. and Maner, J. H. (1971). Green banana meal for feeding growing finishing pigs. *Memoria, Associacion Latinoamericana de Produccion Animal, 6,* 148.

Dormond, H., Rojas, A., Jimenez, C., Quiros, G. (2001). Effect of increasing levels of bluggoe banana pseudostems added to corn silage as roughage, on Jersey calves growing in confinement, during the dry season. *Agronomia Costarricense, 24*(2), 31-40.

Duncan, D. B. (1955). Multiple range and multiple F tests. *Biometrics*, *11*(1), 1-42.

Ecocrop (2010). *Ecocrop database*. FAO

Ekeocha, A. H. (2011). Response of Broiler starters fed rations supplemented with *Vernonia amygdalina* leaf meal (VALM) (bitter leaf). Metabolism and Nutrition Posters. *Poultry Science 90* (Esuppl 1).

Ekpo, A., Eseyin, O. A., Ikpeme, A. O., & Edoho, E. J. (2007). Studies on some biochemical effects of Vernonia amygdalina in rats. *Asian Journal of Biochemistry*, *2*(3), 193-197.

Erasto, P., Grierson, D. S., & Afolayan, A. J. (2006). Bioactive sesquiterpene lactones from the leaves of *Vernonia amygdalina*. *Journal of Ethnopharmacology*, *106*(1), 117-120.

Ffoulkes, D., Espejo, S., Marie, D., Delpeche, M., & Preston, T. R., (1977). The banana plant as cattle feed: composition and biomass production. *Tropical Animal Production, 3*(1), 45-50.

Ffoulkes, D., & Preston, T. R. (1978). The banana plant as cattle feed: digestibility and voluntary intake of mixtures of sugarcane and banana forage. Tropical Animal Production, *3*(2), 125-129.

García, A., Ly, J., & Dominguez, P. L., (1991). Uso de diferentes niveles de harina de residuos foliares del plátano (Musa spp) en piensos secos para cerdos en preceba. Resúmenes IV Congreso ALVEC, La Habana, p 94.

García, C. E., Chicco, C. F., & Carnevali, A. A. (1973). Meal of banana leaves in the feeding of ruminants. *Agronomia Tropical Venezuela, 23,* 293-299.

Gbolade, A. A. (2009): Analysis of antidiabetic plants in selected districts of Lagos State, Nigeria. *Records of Natural Product, 3*(4), 187 – 192.

Heuzé, V., Tran, G., Archimède, H., Lessire, R., & Renaudeau, D. (2011). Bananas fruits. In: *A project by INRA, CIRAD, AFZ and FAO.* Retrieved on 10 June 2021 from http://www.feedipedia.org/node/4670.

Ighodaro, O. M. (2012). Evaluation study on Nigerian species of Musa paradisiaca peels. *Researcher*, *4*(8), 17-20.

Imam, M. Z., & Akter, S. (2011). Musa paradisiaca L. and Musa sapientum L.: A phytochemical and pharmacological review. *Journal of Applied Pharmaceutical Science*, *1*(5), 14-20.

Kimambo, A. E., & Muya, H. M. (1991). Rumen degradation of dry matter and organic matter of different parts of the banana plant. *Livestock Resource Rural Development, 3*(3), 35-40.

Koshimizu, K., Ohigashi, H., Huffman, M. A., Nishida, T., & Takasaki, H. (1993). Physiological activities and the active constituents of possible medicinal plants *Vernonia amygdalina*, *Aspilia mossambicensis* and *Ficus exasperata* used by Chimpanzees of the Mahale Mountains, Tanzania. *International Journal of Primatology, 14*(2), 345-356.

Ling, N., Ueno, N., Ying, S. Y., Esch, F., Shimasaki, S., Hotta, M., Cuevas, P., & Guillemin, R. (1988). Inhibins and activins. *Vitamins and Hormones*, *44*, 1-46.

Ly, J., Garcia, A., & Dominguez, P. L. (1997). Chemical composition of plantain foliage (*Musa paradisiaca*) and the effect of its inclusion in the diet on nutrient digestibility in pig. *Journal of Animal and Feed Sciences*, *6*(2), 257-267.

Ly, J., Postal, G., & Brava, P. (2004). Bananas and plantains for feeding pigs: Aspects of the chemical composition of fruits and their palatability. *Computerized Magazine of Swine Production*, *11*(3), 5-24.

Marie-Magdeleine, C., Boval, M., Philibert, L., Borde, A., & Archimède, H. (2010). Effect of banana foliage (Musa x paradisiaca) on nutrition, parasite infection and growth of lambs. *Livestock Science, 131*(2-3), 234-239.

NRC (1994) National Research Council. Nutrient re- quirements of domestic animals. Nutrient requirements of poultry, 9th revised Edition, National Academy Press. Washington, DC., USA.

Olivo, C. J., Techio Pereira, L. E., Madruga de Carvalho, N., Flores Vogel, F., Heinzmann, B. M., & Neves, A. P. (2007). Use of the banana plant (Musa spp.) for the control of parasites in domestic animals: from empiricism to science. *Livestock Resource Rural Development, 19* (11).

Olobatoke, R. Y., & Oloniruha, J. A. (2009). Haematological assessment of bitter-leaf (*Vernonia amygdalina*) efficiency in reducing infections in cockerels. *Proceedings of the World Congress on Medicinal and Aromatic Plants*, November 9 – 14, 2008, Cape Town, South Africa. Pp. 472-473.

Opata, M. and Izevbigie, E. B. (2006). Aqueous *Vernonia amygdalina* extracts Alter MCF-7 cell membrane permeability and efflux*. International Journal of Environmental Research and Public Health, 3*(2), 174-179.

Owen, A. J., & Amakiri, A. O. (2011). Serological and haematological profile of broiler finishers fed graded levels of bitter leaf (*Vernonia amygdalina*) meal. *Advances in Agriculture and Biotechnology, 1*, 77-81.

Renaudeau, D., Brochain, J., Giorgi, M., Bocage, B., Hery, M., Crantor, E., Marie-Magdeleine, C., & Archimède, H. (2014). Banana meal for feeding pigs: Digestive utilization, growth performance and feeding behavior. *Animal*, *8*(4), 565-571.

Restrepo, A., & Gonzalo, L. (1973). Digestibilidad, valor nutritivo y energético del plátano, Musa paradisiaca L., en cerdos. Thesis PhD, Universidade National de Colombia, Bogota, Colombia.

Reynolds, S. G. (1995). *Pasture-cattle-coconut systems*. RAPA publication No 7, Bangkok, Thailand.

Rowe, J. B., & Preston, T. R. (1978). The banana plant as cattle feed: growth of animals given different proportions of banana tops and sugar cane with molasses ad libitum. *Tropical Animal Production, 3*(3), 193-199.

Solà-Oriol, D., Roura, E., & Torrallardona, D. (2009). Feed preference in pigs: Relationship with feed particle size and texture. *Journal of Animal Science*, *87*(2), 571-582.

Statistical Analysis System (SAS) Institute (2002) SAS/STAT User's Guide. Version 8, 6th Edition, SAS Institute, Cary, 112.

Tadesse, A., Gebre-Hiwot, A., Asres, K., Djote, M., & Frommel, D. (1993). The in vitro activity of Vernonia amygdalina on Leishmania aethiopica. *Ethiopian Medical Journal*, *31*(3), 183-189.

Tsen, J. H., Lin, Y. P., & King, V. A. E. (2004). Fermentation of banana media by using κ-carrageenan immobilized Lactobacillus acidophilus. *International Journal of Food Microbiology*, *91*(2), 215-220.

Uwalaka, N. O., Muoghalu, J. I., & Osewole, A. O. (2018). Species diversity and successional dynamics in the secondary forest of Obafemi Awolowo University Biological Gardens Ile-Ife, Nigeria. *National Conservational Resource*, *3*(1), 21–34.